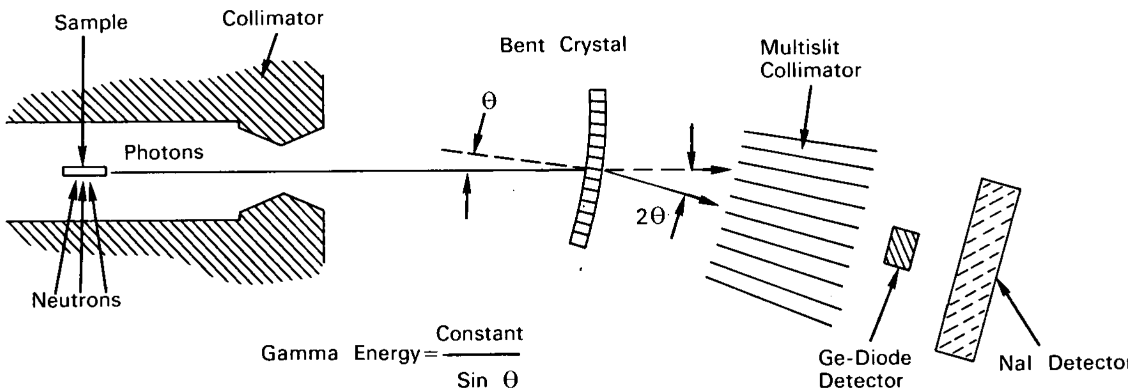
AEC-NASA TECH BRIEF

Ge-Diode Detector Combined With Crystal-Diffraction Spectrometer Permits High-Resolution Gamma Ray Spectroscopy



The problem:

To perform high-resolution gamma-ray spectroscopy on complicated neutron-capture gamma-ray spectra. The most difficult region to analyze is the intermediate range (1–4MeV) where the (n, γ) spectrum is very complicated and the peak-to-background ratios are generally low. This is especially true in the 1–2 MeV range, where the photoelectric cross section is comparable to the pair-production cross section and both are very much less than the Compton cross section.

The solution:

The Argonne 7.7-m bent-crystal gamma-ray spectrometer, combined with a lithium-drifted Ge-diode detector, performs high-resolution gamma-ray spectroscopy on the complicated (n, γ) spectra with significant improvements in resolution, energy precision, and overall sensitivity. The system combines the energy precision of the bent-crystal spectrometer with the high resolution of the Ge diode.

The system is most useful in the 1–3 MeV energy range where both the precision and energy resolution are from 3 to 10 times those of either the bent crystal or the Ge diode used individually. A 50-fold improvement in the signal-to-background ratio is obtained through the use of the combined system.

How it's done:

The Ge-diode gamma detector can be combined with a crystal-diffraction spectrometer in four basic ways, depending upon the type of experiment performed. The general approach is the same in all four configurations. The crystal diffraction process separates out a limited energy region of the γ spectrum and projects it on the Ge-diode gamma detector. The high resolution of the Ge diode then further resolves this narrow region of the γ spectrum into its component parts.

Three important things occur in this process: (1) The gamma rays incident on the detector are limited to the small region under investigation, and the total counting rate in the detector system can be kept quite low without losing sensitivity. This allows the use of amplifiers with a slow response function and therefore the best possible energy resolution. (2) The large background of Compton events from the higher energy gammas in the full spectrum is eliminated, allowing a

(continued overleaf)

marked improvement in the peak-to-background ratio in the Ge detectors. (3) The relative intensity of the individual components of the close doublet or complex structure can be controlled by adjusting the setting of the bent-crystal spectrometer. By recording a set of gamma-ray spectra taken with the Ge-diode detector at different settings of the bent-crystal spectrometer, new additional information about the complex structure can be obtained. For example, one can enhance the weaker member of a close doublet there by making it much more visible (see example) and easier to resolve. It is, in fact, this type of additional information that leads to the improvement in energy resolution over what can be obtained with either system used individually.

NATURAL SPECTRUM SPECTRUM AFTER DIFFRACTION

Notes:

1. Additional details may be found in *Review of Scientific Instruments*, vol. 38, no. 1, p. 52-65 (January 1967).
2. Inquiries concerning this innovation may be directed to:

   Office of Industrial Cooperation
   Argonne National Laboratory
   9700 South Cass Avenue
   Argonne, Illinois 60439
   Reference: B69-10005

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Patent status:

Inquiries about obtaining rights for commercial use of this innovation may be made to:

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